

● HERBICIDE FACTSHEET

# SULFOMETURON METHYL (OUST)

**Sulfometuron methyl is an herbicide in the sulfonylurea chemical family. It is used mostly in nonagricultural situations, including roadsides and other rights-of-way, industrial facilities, and public lands. Oust is a common brand name for sulfometuron methyl products.**

**Sulfometuron methyl-containing herbicides cause eye discomfort, tearing, and blurred vision. In laboratory tests, sulfometuron methyl caused anemia, atrophied testicles and testicular lesions, and increased the incidence of fetal loss. A sulfometuron methyl breakdown product causes DNA damage in the colon of laboratory animals.**

**Because of limited monitoring, little is known about how often sulfometuron methyl contaminates rivers and streams. However, the U.S. Geological Survey found this herbicide in rivers in the Midwest, and the U.S. Forest Service found it in streams following forestry applications.**

**Enough sulfometuron methyl to kill desirable vegetation can persist in soil for a year after application.**

**Minute amounts of sulfonylurea herbicides disrupt plant reproduction. For example, sulfometuron methyl's chemical relative chlorsulfuron reduces fruit production in cherry trees. This reduction is caused by amounts equivalent to 1/1000 of the typical agricultural rate. Experiments with peas, canola, soybeans, and smartweed had similar results.**

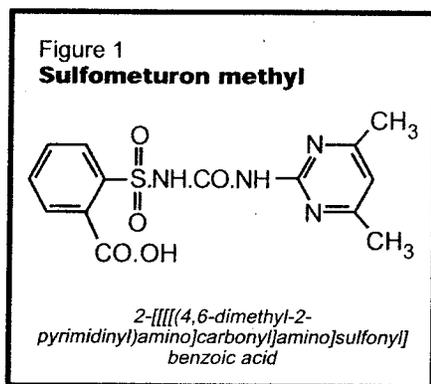
**Drift from roadside and noxious weed applications of Oust have resulted in widespread crop damage totaling millions of dollars.**

BY CAROLINE COX

**S**ulfometuron methyl (see Figure 1) is an herbicide in the sulfonylurea chemical family. This is a relatively new family of herbicides, first marketed in the early 1980s. All sulfonylurea herbicides are extraordinarily potent, about 100 times more toxic to plants than older herbicides, and sulfometuron methyl is "one of the most potent"<sup>1</sup> of this family.<sup>1</sup> E.I. du Pont de Nemours and Company (DuPont) is the major manufacturer of sulfometuron methyl and markets the herbicide under the brand name Oust.<sup>2-4</sup>

**Use**

Sulfometuron methyl is used as a broad spectrum herbicide (for total vegetation kill) in nonagricultural sites such as fence rows, roadsides and other rights-of-way, storage areas, industrial facilities, and public lands. It is also used as a selective herbicide



on conifer plantations, hardwood plantations, and turf. To use it as a selective herbicide in these situations, applications must occur during times when the crop tree or turf is less susceptible to Oust (during winter dormancy for trees, and when turf is well established).<sup>2-4</sup>

**Mode of Action**

Sulfometuron methyl kills plants by stopping the division of growing cells, particularly cells in the tips of plant roots. On a molecular level, sulfometuron methyl inhibits the activity of

an enzyme called acetolactate synthase (ALS). ALS is one of the enzymes used by plants to synthesize three specific amino acids, molecules that are used as components of proteins.<sup>5</sup> Animals do not have the ALS enzyme.<sup>1</sup>

**"Inert" Ingredients**

Like most pesticides, sulfometuron methyl herbicide products contain ingredients in addition to sulfometuron methyl. Many of these ingredients, according to U.S. pesticide law, are called "inert."<sup>6</sup> Some inert ingredients in sulfometuron methyl products have been identified by the U.S. Environmental Protection Agency (EPA). These include sugar, the sodium salt of a naphthalene-sulfonic acid formaldehyde condensate, the sodium salt of sulfated alkyl carboxylated and sulfated alkyl naphthalene, hydroxypropyl methylcellulose, and polyvinyl pyrrolidone. All are ingredients in Oust Herbicide (EPA Registration Number 352-401).<sup>7</sup>

The following six sections of this article discuss the toxicology of Oust herbicides, including information about sulfometuron methyl, Oust's inert

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ingredients, and sulfometuron methyl breakdown products. With the exception of the studies of eye irritation in the next section, all of the studies summarized were conducted on a single ingredient, not on the combination of ingredients found in sulfometuron methyl herbicide products.

### Eye Irritation and Injury

Commercial sulfometuron methyl-containing herbicides can injure eyes. Oust and Oust XP both cause eye discomfort, tearing, and blurred vision. A third sulfometuron methyl herbicide product, Oustar, is corrosive to eyes and causes irreversible eye injury.<sup>8-10.</sup>

### Effects on the Circulatory System

Sulfometuron methyl causes anemia. In a laboratory study that was

conducted by sulfometuron methyl's manufacturer (DuPont), dogs fed sulfometuron methyl for a year had fewer red blood cells and less hemoglobin in their blood than unexposed dogs. These effects occurred at lower doses in females than they did in males.<sup>11</sup> (See Figure 2.)

Sulfometuron methyl also affects white blood cells. In a laboratory study conducted by DuPont, rats fed sulfometuron methyl for three months had more white blood cells,<sup>11</sup> including a special kind of white blood cell called a lymphocyte,<sup>12</sup> than unexposed rats.<sup>11</sup> These effects occurred at a dose level of approximately 400 milligrams per kilogram (mg/kg) per day.<sup>11</sup>

### Effects on the Lungs

According to the International Agency for Research on Cancer, exposure of people to polyvinyl pyrrolidone, an Oust ingredient, "may be accompanied by pulmonary fibrosis and pneumonia."<sup>13</sup> Pulmonary fibrosis is the development of fibrous tis-

sue in the lungs.<sup>12</sup>

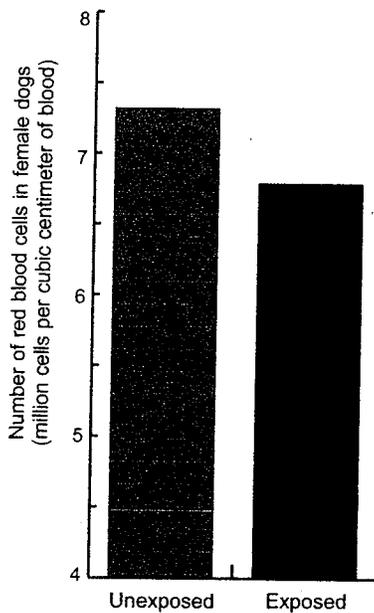
### Effects on Reproduction

Exposure to sulfometuron methyl can disrupt successful reproduction in a variety of ways according to laboratory studies conducted by DuPont.

Effects on the testes have been documented in studies with both rats and dogs. The study with rats was a small study in which rats were fed high doses of sulfometuron methyl for 10 days. Two of the six rats developed testicular problems: one had abnormally small testes and another developed lesions.<sup>14</sup> In a study in which dogs were fed sulfometuron methyl for a year, the testes of three of the six dogs exposed to sulfometuron methyl degenerated and two dogs developed atrophied testes.<sup>11</sup> (See Figure 3.) No abnormal testes occurred in unexposed animals.<sup>11,14</sup>

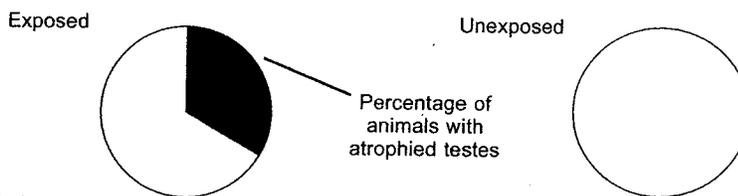
Effects on pregnant animals have been documented in both rats and rabbits. The offspring of rats exposed to sulfometuron methyl during the middle

Figure 2  
**Sulfometuron Methyl Causes Anemia**



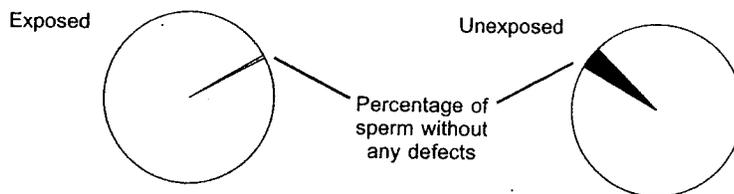
Source: U.S. EPA. 1983. E.I. duPont. Oust Weed Killer, ID#352-401, Caswell #561D, Accession #250590. Memo from A. Arce, Toxicology Branch, to R. Taylor, Registration Div. Washington, D.C., Dec. 1.

Figure 3  
**Sulfometuron Methyl Causes Atrophied Testes**



Source: U.S. EPA. 1983. E.I. duPont. Oust Weed Killer. Memo from A. Arce, Toxicology Branch, to R. Taylor, Registration Div. Washington, D.C., Dec. 1.

Figure 4  
**An Oust "Inert" Ingredient Damages Sperm**



Source: Strehler, E. et al. 1998. Detrimental effects of polyvinylpyrrolidone on the ultrastructure of spermatozoa. *Hum. Reprod.* 13: 120-123.

Sulfometuron methyl caused anemia and atrophied testes in a laboratory test. In addition, an "inert" ingredient in Oust damages sperm.

part of their pregnancies were smaller than offspring of unexposed animals. This effect occurred at a dose level of about 400 mg/kg per day.<sup>11</sup> In a two-generation study, feeding of sulfometuron methyl decreased the number of offspring in a litter. This effect also occurred at a dose level of about 400 mg/kg per day.<sup>14</sup> In rabbits exposed during the middle part of their pregnancies sulfometuron methyl increased the incidence of fetal loss.<sup>15</sup>

In addition, the Oust ingredient polyvinyl pyrrolidone damages sperm. In a study conducted by a researcher at the Institute for Reproductive Biology (Germany) and his colleagues, the proportion of undamaged (human) sperm was ten times less for sperm exposed to polyvinyl pyrrolidone than for unexposed sperm.<sup>16</sup> (See Figure 4.)

#### **Mutagenicity (Ability to Cause Genetic Damage)**

According to DuPont, "sulfometuron methyl did not produce genetic damage in bacterial or mammalian cell cultures."<sup>10</sup> However, sulfometuron methyl can break down into saccharin<sup>17</sup> (a compound that is used as an artificial sweetener) and that compound causes genetic damage. According to a study conducted by researchers at the Hachinohe National College of Technology (Japan), a single (large) dose of saccharin causes DNA damage in the colon of laboratory animals.<sup>18</sup> DNA is the molecule inside cells that carries genetic information.<sup>12</sup>

#### **Carcinogenicity (Ability to Cause Cancer)**

According to DuPont, "animal testing indicates that the active ingredient, Sulfometuron Methyl, does not have carcinogenic effects."<sup>8</sup> However, another Oust ingredient, polyvinyl pyrrolidone, "was tested for carcinogenicity in mice, rats, and rabbits by several routes of administration, providing local tumours" according to an evaluation by the International Agency for Research on Cancer.<sup>13</sup> These tumors were mostly a kind of cancer called sarcomas.<sup>19</sup>

#### **Contamination of Water**

Use of sulfometuron methyl can

result in contamination of rivers and streams, although monitoring for sulfonylurea herbicides in water is limited and "little is known about their occurrence, fate, or transport in surface water or ground water in the United States."<sup>20</sup>

The U.S. Geological Survey found sulfometuron methyl in river and stream samples in agricultural areas in the Midwest, and the U.S. Forest Service found sulfometuron methyl in streams following forestry applications in Mississippi and Florida.<sup>20,21</sup>

### **" The U.S. Geological Survey found sulfometuron methyl in river and stream samples in agricultural areas in the Midwest, and the U.S. Forest Service found sulfometuron methyl in streams following forestry applications in Mississippi and Florida."**

Incidents in which water contaminated with Oust damaged desirable vegetation have been reported from Tennessee, Pennsylvania, Arkansas,<sup>22</sup> and Washington.<sup>23</sup>

Sulfometuron methyl also has the potential to contaminate groundwater. Like all sulfonylurea herbicides, it is "relatively mobile in soil,"<sup>24</sup> according to EPA, and has a "high intrinsic leaching potential."<sup>24</sup> Its breakdown products have similar characteristics.<sup>24</sup>

#### **Effects on Frogs**

Sulfometuron methyl causes a variety of developmental effects on frogs.

A study conducted by The Stover Group (an environmental consulting firm) showed that sulfometuron methyl inhibited tail resorption in tadpoles. (Tail resorption is part of the process by which a tadpole matures into a frog.) This inhibition occurred at a concentration of 10 parts per million (ppm) with chemically purified sulfometuron methyl and 1 ppm if not purified.<sup>25</sup>

Other effects on frog development of sulfometuron methyl (not chemically purified) include malformed limbs and increased mortality. These effects occurred at concentrations of 5 and 10 ppm respectively.<sup>25</sup>

The Stover Group researchers concluded that these developmental effects are caused by sulfonylurea herbicides' ability to disrupt thyroid function, and stated that such disruption "is capable of producing a myriad of deleterious effects."<sup>25</sup>

#### **Effects on Fish**

Concentrations of sulfometuron methyl required to kill fish are relatively high (over 12.5 ppm).<sup>26</sup> Because of this low aquatic toxicity, a fish related to Oust use is of particular interest. In spring 1983, the Tennessee Department of Transportation sprayed about 6,000 acres of rights-of-way. Heavy rains followed the spraying, resulting in fish kills.<sup>22</sup>

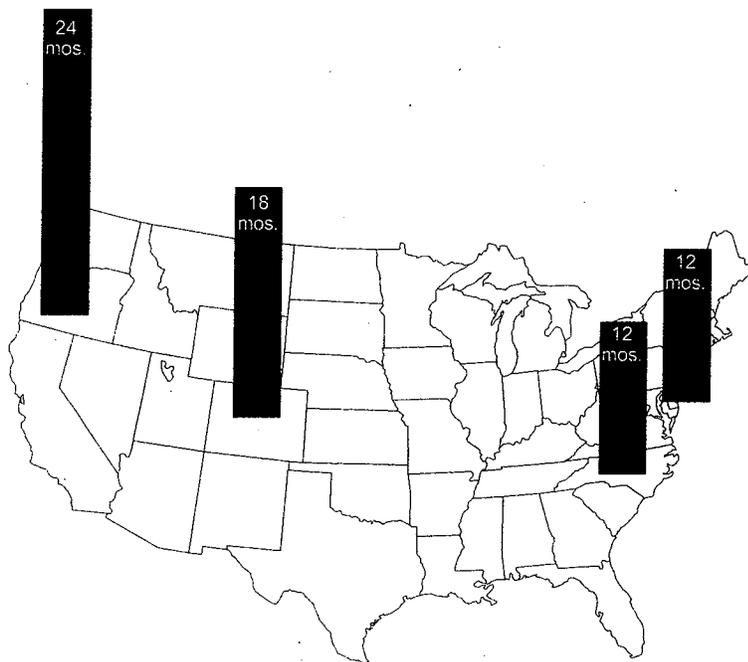
#### **Effects on Algae**

Low concentrations of sulfometuron methyl kill algae. In a laboratory test conducted by DuPont, concentrations above 0.63 parts per billion (ppb) killed the green algae *Selenastrum capricornutum*.<sup>27</sup>

#### **Persistence in Soil**

There is no simple answer to the question, "How long does sulfometuron methyl remain in soil?" EPA classifies sulfometuron methyl as "moderately persistent."<sup>28</sup> Oust's half-life (time required for half of the applied sulfometuron methyl to break down or move away from the application site) has been measured by DuPont researchers to vary between 12 and 25 days<sup>29</sup> and by Forest Service researchers to vary between 5 and 33

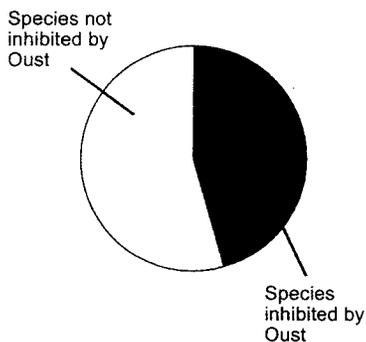
**Figure 5**  
**Persistence of Sulfometuron Methyl in Soil**



Source: Anderson, J.J. and J.J. Dulka. 1985. Environmental fate of sulfometuron methyl in aerobic soils. *J. Agric. Food. Chem.* 33:596-602.

According to field studies conducted by Oust's manufacturer, sulfometuron methyl persists in soil between one and two years.

**Figure 6**  
**Effect of Oust on Soil Microorganisms**



Source: Burnet, M. and B. Hodgson. 1991. Differential effects of the sulfonyleurea herbicides chlorsulfuron and sulfometuron methyl on microorganisms. *Arch. Microbiol.* 155:521-525.

Oust inhibited almost half of the species of soil microorganisms studied in a laboratory test.

days.<sup>21</sup>

It takes at least a year for enough Oust to break down so that treated land can be used for crops. The label for Oust® Herbicide states, "If noncrop or forested sites treated with OUST® XP are to be converted to a food, feed, or fiber agricultural crop, or to a horticultural crop, do not plant the treated sites for at least one year after the OUST® XP application."<sup>3</sup> Even after one year, the label recommends field testing prior to planting a crop.<sup>3</sup>

This label requirement is based on the time required for nearly all of the applied sulfometuron methyl to break down. This can be long. For example, a second DuPont study measured sulfometuron methyl residues two years after applications made in Oregon and 18 months in Colorado.<sup>30</sup> (See Figure 5.)

One of Oust's common uses is to control vegetation along roadsides, which often have alkaline soils be-

cause of lime and limestone used during construction. Alkaline soils increase the persistence of sulfometuron methyl.<sup>1,31</sup>

**Effects on Soil Microorganisms**

Because some soil microorganisms rely on acetolactate synthase, the enzyme inhibited by sulfonyleurea herbicides, they are quite susceptible to sulfometuron methyl. Microbiologists at the University of Melbourne (Australia) found that, of eleven soil bacteria studied, the growth of five species was inhibited by treatment with Oust. (See Figure 6.) The biologists concluded that application of Oust "would have significant effects on the microbial ecological balance of the soil."<sup>32</sup>

A study of Christmas tree weed management in Kentucky demonstrated this kind of effect on soil ecology. The study compared the use of Oust and sawdust mulches in a Christmas tree plantation. The foresters, from the University of Kentucky, showed that Oust treatment (compared to untreated areas) had a negative impact on the abundance of microorganisms and decreased the soil nitrogen content, while sawdust treatment increased both microorganisms and nitrogen content.<sup>33</sup>

**Effects on Plants**

Sulfometuron methyl is extraordinarily potent; for example, a concentration of 0.1 ppb in soil kills sugarbeets,<sup>28</sup> and a concentration of 0.06 ppb in water reduces growth of the native aquatic plant common water milfoil.<sup>34</sup>

Another illustration of its extraordinary potency is that the Oust label prohibits using equipment that has been used to apply Oust to apply any other pesticide. "This is extremely important," states DuPont, "as low rates of OUST® XP can kill or severely injure most crops."<sup>3</sup>

However, even more extraordinary is the ability of this herbicide family to disrupt plant reproduction at exposure levels that are far less than the tiny amounts needed to kill plants.

EPA researchers have conducted a series of studies with sulfometuron methyl's chemical relative chlorsulfuron that document how minute exposures

reduce fruit or seed production. In the first study, looking at cherry trees, spring applications (when immature cherries were about half of their full size) of chlorsulfuron equivalent to one thousandth of typical agricultural application rates reduced the amount of fruit produced. Fall applications at similar low levels caused fruit production to drop the following year. Neither fall nor spring applications caused visual damage to leaves, branches, or other vegetative parts of the tree.<sup>35</sup>

The subsequent studies looked at impacts on other plants: garden peas, canola, soybeans, sunflower, and smartweed. Results were similar. Exposures equivalent to two thousandths of typical application rates reduced canola, soybean, and smartweed seed production; exposures of four thousandths of typical rates reduced pea production; and slightly higher exposures impacted sunflowers. (See Figure 7.) Again, reductions in fruit and seed production often occurred without visible signs of injury to the vegetative parts of the plant.<sup>36,37</sup>

The first of these studies begins by pointing out that sulfonylurea herbicides could have a "devastating impact."<sup>35</sup> The researchers' conclusions are sobering: "drifting sulfonylureas may severely reduce both crop yields and fruit development on native plants, an important component of the habitat and foodweb for wildlife."<sup>35</sup>

### Effects on Endangered Species

Because sulfometuron methyl is a potent broad spectrum herbicide, it can kill endangered plants if they are exposed. In 1983, the U.S. Fish and Wildlife Service completed a formal consultation with EPA as required by the Endangered Species Act regarding potential impacts on endangered species of right-of-way and ditch bank use of Oust. The Fish and Wildlife Service identified 25 endangered plant species in 13 states that occur on or near rights-of-way and pointed out that "because of the limited population size of many of these plant species, a local spraying program could virtually destroy the entire species."<sup>38</sup>

In the 1983 consultation, the Fish

and Wildlife Service suggested prohibiting rights-of-way uses of Oust in counties that were home to the 25 identified endangered species.<sup>38</sup> However, Oust labels merely prohibit use in five counties in Colorado;<sup>3</sup> there are only voluntary guidelines to protect endangered species elsewhere.<sup>39</sup>

### Wind Transport

Off-target movement of sulfometuron methyl has caused dramatic crop damage. For example, an investigation by the Idaho Department of Agriculture recently (2002) concluded that several million dollars worth of crops were damaged by wind transport from an aerial Oust application made by the Bureau of Land Management to kill cheatgrass following a wildfire.<sup>40</sup> Over a hundred farmers and ranchers reported damage on over 100,000 acres.<sup>41</sup>

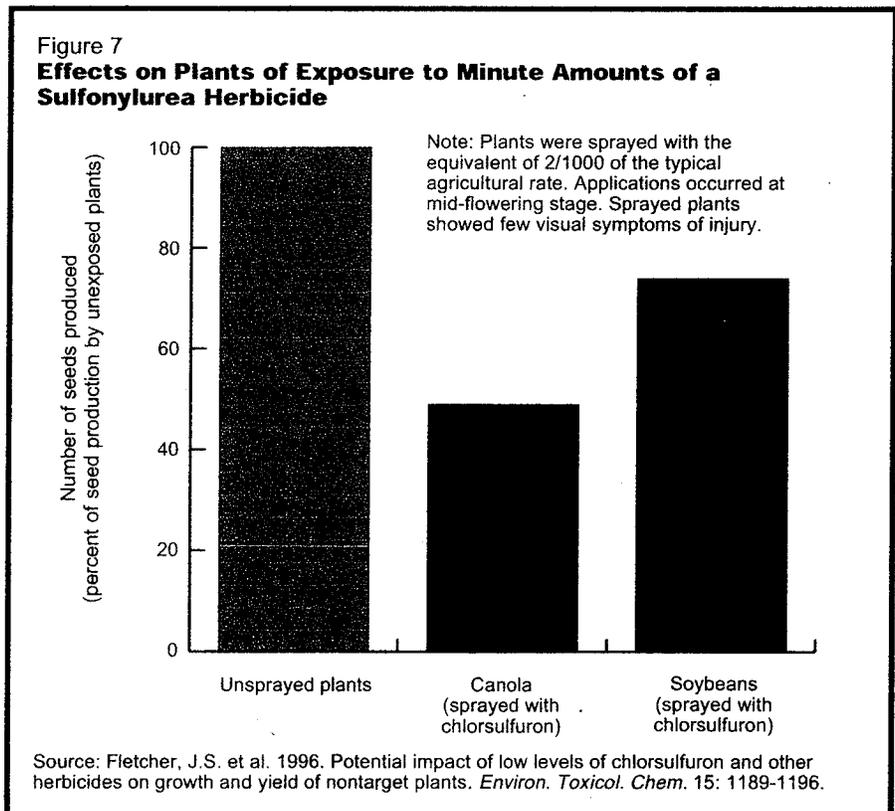
The first well-documented, large-scale Oust wind transport incident occurred in 1985. County and state road crews applied Oust to over 700 miles

of roadsides in Franklin County, Washington, and subsequent wind transport caused over a million dollars of damage. In one nursery over 300,000 young trees were damaged.<sup>42</sup>

Investigation and documentation of these incidents has been hampered because, until recently, analytical methods for detecting sulfonylurea herbicides were not sensitive enough to detect the low concentrations of these herbicides that caused plant damage.<sup>1</sup> This meant that there was no way to analytically determine the cause of damage caused by low sulfometuron methyl concentrations. In 2001, however, the U.S. Geological Survey developed a sophisticated analytical method for detecting sulfonylurea herbicides at concentrations of 10 parts per trillion.<sup>20</sup>

### Resistance

Weeds that are resistant (able to tolerate exposure) to sulfonylurea herbicides, including sulfometuron methyl,



Exposure of plants to extremely small amounts of sulfonylurea herbicides while they are flowering causes significant reductions in seed production.

are widespread. At least 73 weed species have developed resistance.<sup>43</sup>

Characteristics of resistance to sulfometuron methyl that raise special concerns include the following:

- **Cross resistance.** This type of resistance occurs when plants that have developed resistance to one herbicide are also resistant to other herbicides. Weed populations that have developed resistance to sulfometuron methyl can be resistant to other unrelated herbicides. For example, scientists from Alberta, Canada's agriculture department studied a false cleavers population that was resistant to a broad range of sulfonylurea herbicides, including sulfometuron methyl. The population was also resistant to quinclorac,<sup>44</sup> an auxin-type herbicide that acts by mimicking natural plant growth hormones.<sup>45</sup> Cross resistance also occurs with herbicides that share sulfometuron methyl's mode of action but are from other chemical families.<sup>46,47</sup>

- **Frequent occurrence.** Genes that confer sulfometuron methyl resistance are found in weed populations that have never been sprayed with this herbicide. For example, University of Western Australia researchers studying rigid ryegrass populations that had never been treated with sulfonylurea herbicides found sulfometuron methyl-resistant individuals in all three populations studied.<sup>48</sup> This means that weed populations can develop resistance to sulfonylurea herbicides quickly. Resistant populations of weeds have appeared after only four applications of a sulfonylurea herbicide.<sup>1</sup> †

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